



Indigenous Knowledge Adaption Strategies in Response to Climate Change: The Case of North Gondar, Ethiopia

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Abstract

The study was conducted in North Gondar Zone to identify the climate change variables and farmer's indigenous climate change adaption strategies. The study took a sample of 130 farmers by using appropriate sampling techniques. Quantitative and qualitative data were collected from primary and secondary sources. Descriptive analysis was used to analyze farmer's indigenous climate change adaption strategies quantitative. Besides, qualitative data were analyzed through narration. Different climate change variables, which affect livelihood of farmers, and variety of indigenous adaption strategies to minimize hazard due to climate change were identified. People living in the zone use indigenous adaption strategies based on Agro-ecology and farming system. The finding of research indicates that farmers adapt different strategies in response to different climatic change variables, and there are no best practices that can be used to tackle all climate change variables. Hence using a blend of the indigenous and scientific adaption strategies across the appropriate contexts is, therefore, of paramount importance.

Keywords: Adaptation; Climate; Indigenous; Knowledge; Strategies

Introduction

Ethiopia is one the agrarian country whose main livelihood depends on agriculture as source of income. Farmers whose livelihoods depend largely on rain-fed agriculture were faces with different climate variability [1]. Condition such as being low economic development, inadequate infrastructure and lack of institutional capacity contributes Ethiopia for vulnerability to climate change. These conditions have also leads country for land degradation and climate-related natural hazards [2]. Climate change is becoming a serious problem for Ethiopian farmer by affecting lives and livelihoods [3]. The Government of the Federal Democratic Republic of Ethiopia (GOE) is responding to the challenge of climate change through ratification of different policies. To safeguard economic growth and reducing the country's vulnerability to climate change the Climate-resilient green economy (CRGE) Strategy was implemented through reducing greenhouse gas emissions [4].

In different part of the country, households adapt different strategies in order to tackle the effects of climate change related risks [1,4,5]. Indigenous knowledge as strategy appears pertinent for sustainable development, addressing issues of protection of biodiversity and starting point for the construction of alternative agriculture in the rural communities (Isabel A Gutierrez-Montes and Edith Fernandez-Baca). Besides, recognizing indigenous adaption strategies of communities' can be valuable for decision-making processes and reduction of climate change hazards, which face the country's population [2].

Some of the studies were conducted in Ethiopia with some limitations. According to Tsegaye, Atinkut and Mebrat, farmers utilize different adaption strategies for climate change. However, the study lacks detail information about climate related hazards and their adaption strategy separately. According to Abate [5], communities utilize different indigenous adaption strategies. However, the researcher did not clearly show for which climate variable those indigenous adaption strategies were utilized. According to the Sisay [6] study result indicates that vulnerability of small holder farmers by climate change vary from district to districts based on adaptive capacity of farmers and natural resource endowment (water). However, the researcher did not identify climate change variables and indigenous knowledge as adaption strategy for climate change.

In study areas, communities have indigenous adaption strategies to adapt climate change related risks. Existence of these strategies may help

for improving existing scientific knowledge and a basis for designing appropriate policies. However, researchers and development experts have given less emphasis to the indigenous knowledge to adapt climate change related risks. To the best of author's knowledge, there is little empirical evidence on indigenous climate change adaption strategies in Ethiopia particularly North Gondar Zone of Amhara region, Ethiopia. Hence, this study was conducted to fill the information gaps in the study areas. Hence, the objectives of the study were:

- (1) Identifying indigenous adaptation strategies in response to climate change, and
- (2) Identifying climate change variables that can be adapted through indigenous knowledge adaptation strategies.

Research Methodology

Sampling techniques and sample size

The study employed two sampling technique such as purposive and simple random sampling. Based on being representatives both districts and kebeles were selected through purposive sampling. Among 24 Districts of the zone, three namely Dabat, Gondar Zuria and West Belesa districts representing the highland (Dega), mid land (Woina Dega) and Lowland (Kolla) were taken as the study areas, respectively.

Yamane determined the sample size for this study
$$n = \frac{N}{1 + N(e^2)}$$

Where: n=Sample size, N=Population size and e=level of precision

(0.09). Therefore,
$$n = \frac{6786}{1 + 6786(0.09^2)} \approx 121$$
 But due to need of

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additional information 9 respondents were added. Hence, 130 sample respondents were the sample size of this study to collect data to attain objective of the study.

The sample size for each sample kebeles was proportional to the total number of their respective households. After the determination of sample size for each sample kebele proportionally, simple random sampling technique by using random number table was applied to select decided sample size of each kebeles. So that the total numbers of the sample respondents in Debat 48, Gondar Zuria 36 and West Belesa 46 farmers i.e., 130 sample respondents were randomly selected and interviewed through structured questionnaire from the three districts.

Data collection and analysis

Secondary data: Both qualitative and quantitative secondary data related to characteristics of districts and sample respondents were collected before collection of primary data from agricultural office.

Primary data: The primary data were collected by using different tools such as focus group discussion, key informant interview, sample household interview through schedule and observation. Focus group discussion and key informant interview was held with community leader, farmers and experts to collect information on climate change variables and indigenous climate change adaption strategies.

Sample household interview through schedule: Was designed to collect primary data. The main primary data types collected include different climate change variables and indigenous adaption strategies for adapting different climate change variables. Data collected through household interview was both qualitative and quantitative. Whereas data collected through focus group discussion, key informant and observation were more of qualitative in nature.

After the collection of both qualitative and quantitative data to achieve stated objectives descriptive analysis was utilized to analyse quantitative data whereas qualitative data were analysed through narration. In the descriptive part of the analysis, mainly percentage was used to analyse data quantitatively. Statistical Package for Social Sciences software (SPSS) version 20 was utilized to carry out analysis.

Results and Discussion

Climate change vulnerabilities and indigenous adaption strategies

Climate change variables that influence stallholder farmer livelihood were temperature, rainfall, wind, flood, drought, frost, pest (insect, disease and weed), crop production, livestock production, soil fertility, surface and ground water availability, surface and ground water quality, ice, declining trends of grazing land, biodiversity (plant and wild animals) and forest coverage change.

In the study areas, farmers had been practiced in different adaptation strategies that enabled them to reduce susceptibility to climate change. According to the Abate [5] alteration of planting date of crops is major adaption strategy for climate change. Alteration of planting date of crops was one strategy that was utilized by farmers to harmonize with the changing conditions. The study revealed that the 90% of respondents used alteration of planting date as adaption strategy for climate change. Alteration of planting dates as adaption strategy for climate change had been made by pushing backward and pulling forward the time from the normal by looking the pattern of whole weather and rainfall. Alteration of planting date as adaption strategy for climate change had been used to adapt climate change hazards such

as temperature, rainfall, drought, frost, crop disease, weed infestation, crop production and productivity and soil fertility.

Accumulation of livestock or another asset was the indigenous adaption strategy for climate change [5] among the sample respondents, in study areas 68.5% of them practiced storage of extra harvest for food supply in the future as climate change adaption strategies to tackle the problems that might arise from rain fall, drought, human disease, crop failure and number of plant related vulnerability. On the other hand, crop diversification was also found one of the strategies of climate change adaptation in the study areas. From randomly sampled respondents, 93.1% of the farmers used crop diversification as climate change adaption strategy to cope with wind, crop disease, weeds infestation, crop production and soil fertility related issues. In the Ethiopia, other studies also indicate that crop diversification is one of farmer's adaption strategies for climate change [1,5].

According to Abate [5] communities utilize inter cropping as indigenous adaption strategies. The study has also revealed that 80.8% farmers indigenously practiced intercropping as adaption strategy. By using this strategy, they adapt risks related to soil fertility, crop production, weed infestation, crop disease, livestock disease, drought, flood and wind. The 97.7% sample respondents practiced choosing crops and varieties better adapted to the expected length of the growing season as indigenous climate change adaption strategy. According to the study result problems related with crop production, weed infestation, crop disease, drought, rainfall and temperature had been tackled by using this climate change adaption strategy.

Alteration of crop planting had been practiced as strategy to cope with the changing temperature, drought, frost, crop production and 92.3% sample respondents have reported that this is common to their households. Interestingly, reducing number of livestock at household level was found to be the common practices among the farmers in North Gondar Zone. In connection with this, 66.9% of respondents said reducing number of animal had been practiced in response of the changing climate conditions, which significantly reduce availability of livestock feed. Reducing the number of the livestock at households is not only the response to climate change effects, but also strategy for declining trends of grazing land. According to the Tsegaye [7] change livestock type sheep and cattle in to goat and hen due to desertification is one adaption strategy of farmer to the climate change in pastoral areas.

Participation of off-farm and non-farm income generating activities were the strategies used for farmers as adaption strategies [5,7] According to Tsegaye [7], off farm and nonfarm activities in which farmers engaging includes weaving, carpeting and pottery were used to adapt decrease in income from agriculture and lack of land. Alternative income sources for farmers as adaption strategy were also used like petty trade, sale of charcoal, and firewood [5] Apart from using different crop production strategies, off-farm income generative activities like trading were also found to be adaption strategy to minimize the risks related to rainfall and drought. Among respondents, 30.8% of farmers practiced off-farm and non-farm income generating activities as adaption strategy in the study area. In connection with this, the data obtained from focus group discussion and key information interview show that seasonal migratory labor for off-farm income generating activities is common in the study areas. Seasonal migration was also used in different study areas as adaption strategy [1] Farmers from highland areas such as Dabat and Gondar zuria, migrate to lowland area such as Metema, where there was higher labor demand during peak times of weeding and harvesting of sesame. Even if the number of individuals

engaged in irrigation practice were small due lack of water, land near to river, lack of awareness use and method of irrigation, farmers utilize irrigation for adaption of fluctuation of rainfall [7].

Erratic nature of rainfall has placed farmers to confront with uncertainty in their production system to sustain their livelihoods. In response to this situation, farmers have practiced water harvesting during the time when there is excess water. However, it was experienced with few households, representing only 22.3% of farmers. Despite, the huge potential for irrigation water both from surface and ground water, the household who have experience the small-scale irrigation schemes to production mainly vegetables and fruits is limited to 35.4% of household representing the study areas. According to different studies, changing crop type i.e., late maturing by early maturing is one of the farmer's adaption strategies for climate change [5,7] Farmers in the study areas have recognized that for uncertain and short duration production seasons due to climate need genuine reactions. In respond to short duration of the raining and other related issues, 94.6% of farm households had been experiencing growing of early maturing crop as adaption strategy.

According to Abate and Tsegaye [5,7] planting trees and Agro-forestry were also used as the adaption strategies, respectively. The farmers in the study areas have also long-lasting knowledge of responding to climate change. As it was reported by 53.8% of sample respondents, farm households are using Agro-forestry type of production as strategy to integrate sustaining the production for the household demand and maintaining natural resources. In the areas where Agro-forestry system of production is used, additional opportunities such as honey production and maintaining surface water resources was observed. The Agro-forestry system of production as perceived by farming community, is not only means of adaptation strategy, but is also the way to conserve the biodiversity specific to the given Agro-ecology. In addition to Agro-forestry practices, the farm households are also adopted the production and protection of forest resources specially, which are in communal land. The experience of planting trees around the homestead and closing the areas to make free of animal grazing are also the emerging strategies of the farming community in the study area.

Soil and water conservation was used for climate change adaption in different areas [5]. In the study area aside from massive government-initiated soil and water conservation, farm households are responsive to use the strategy to conserve their farmlands. Soil and water conservation practices at household level not only as adaption strategy but also to maintain sustainable household food production was used to reduce flood and soil fertility losses. Avoiding disease contaminated crop, using disease tolerant crop, pulse crop production, weeding before flowering and burning of weed are farmers adaption strategies which have been practiced for reducing challenges related with soil fertility, weed infestation, crop disease and crop production. Adjusting Agronomic practices like use of input like fertilizer was one the adaption strategy for climate change [5].

As part of good Agronomic practices of smallholders, using organic fertilizer as means of boosting production and productivity of land was also observed in the study area. In line with this 89.2% of households locally prepared organic fertilizer such as cow dung, crop residue and compost. Nonetheless, the utilization of organic fertilizer such as cow dung were the responses of number of livestock per households. The evidences from available data indicated that 95.4% of the sample respondents have used changing cropping mix for climate change vulnerabilities, which might arise from erratic rainfall, flood, drought, crop disease, weed infestation, and soil fertility problems.

The shift from annual crops to perennials was one of the adaptation strategies to go with changing trends of climate variables such as temperature, precipitation, wind and relative humidity, which could significantly affect the production of seasonal based (annual crops). The shift from annual crops such as cereals, pulses and oilseeds to perennials including mango, apple (in the highlands), avocado, lemon, papaya and the like were practiced being by 32.3% of the farmers in North Gondar Zone.

According to Abate [5] use of minimum tillage was used for climate change adaption strategy. In study area farm households have used conservation tillage as adaptation strategy. The result from household survey data reveals that 95.4% of sample respondents use conservation tillage to reduce the soil erosion due to flood and wind. On the other hand, maximizing soil disturbance (87.7%) was also reported to be very good strategy management of crop and maintenance of soil fertility. Increasing tillage frequency/maximizing soil disturbance was also used for reducing weed infestation, increasing crop production, enhancing soil fertility and prevention of crop disease.

Farmers employ adjusting timing of farm operation such as sowing date, management practices and harvesting as adaptation strategy. As far as adjusting time of operation and management practices was concerned, 86.9% of respondent farm households have reported as they practice. However, that this mainly done after forecasting the likely and unlikelihood of occurrence of rainfall. Sample respondents used this adaption strategy for adapting temperature, rainfall, wind, flood, drought, crop disease, weed infestation, crop production, livestock production, soil fertility and forest coverage change.

As it was in crop production and management, different livestock production and management practices were identified as adaptation strategies of climate change. As far as climate change responsive animal production and management is concerned, 93.1% of respondents perceived that there was a change in livestock management system. Though, it was limited to few farm households, animal shelter, sanitation, shifting from fodder to concentrated animal feeds, animal health care, shifting from free grazing to zero grazing are reported to be emerging animal production and management systems. The 96.9% sample respondents had practiced forage collection and reserving as it was used for time when there was shortage of animal feed. Climate change variables such as wild animal, livestock production, crop production, livestock disease and human disease were adapted through adjust livestock management.

In addition to food reserve practices, farmer households had long lasting experiences of preservation of product to increase to the shelf life. Accordingly, 91.5% of the sample respondents reported that they use different post harvesting techniques that include drying, smoking by selected smoke woods, and using of different storage technique. The post-harvest handling techniques of the farmers could be categorized into mechanical and chemical ways. The mechanical techniques were mainly used to protect from insect infestation whereas the chemical techniques mainly used for seed preservation.

Crop and livestock integration was locally practice climate change adaption strategy in study areas. The data obtained using household survey indicates that 84.6% of farm households studied, crop livestock integration as part of mixed agricultural production system. The strategy was used because of complementary integration between livestock and crop. However, there is not balanced, well-planned and properly managed crops livestock integration. As part of crop- livestock integration, animal was used not only as source of traction power and

fertilizer, but also serve the resource of the last resort for shortage of food crops. Sample respondents used this strategy to adapt livestock production, drought, and livestock disease and crop disease.

According to Abate [5], communities utilized traditional mutual social supporting system (support poor households or those who have lost many assets due to hazards such as droughts, conflicts or diseases) for the adaption of climate change. Agricultural extension communication is the major means of disseminating information to the farmers. With the same token, indigenous or traditional way of communication are paramount important to exchange information from one to the other and to get support one from the other. To this effect, exiting social interactions are the important channels through which information was passed. Owning the fact that traditional media and social interactions are useful, farm households tend to strengthen existing social interactions built through cooperatives, edir, equib, senbetie and the like. According to information obtained from respondent households, 93.1% have reported that they tend to strengthen the social interactions as mean of getting information related to climate change and related issues.

Climate change had multi-dimensional effect on people and biophysical environment. The data obtained from household survey and focus group discussion indicate that in response to increasing temperature and fluctuation in some time imposed the people to change the dressing style and type of houses being constructed. As the result, 66.2% of respondent believe that due increasing or fluctuation of temperature, people have changed the style of home construction and dressing. Interestingly, the data obtained from qualitative sources indicate that due to change in the weather the houses which are constructed with grass roofed are preferable than ever. According to Abate [5], communities praying as climate change adaption strategy. In line with this in study area, farmers also use praying and traditional medicine for protecting fell of ice. Because they believed that, it is the God resentment (Egizebhier kuta).

Conclusion and Recommendations

In reality, many research studies concluded that climate change is increasing and will increase in future. In response to these harsh conditions farm community were used indigenous climate change adaption strategies. Indigenous adaption strategies were contributed for providing solution/remedy for the changing environment in their working environment. These indigenous adaption strategies were essential for understanding either local or worldwide impacts of climate change on socioeconomic, political and environmental development/wellbeing of the people.

The results of study reveal that sample respondents utilize different indigenous adaption strategies based on Agro-ecology and farming system. Thus, the percentage utilization of adaption strategies varies from household to household. Farmers utilize adaption strategies for adapting climate change vulnerabilities that face their wellbeing were temperature, rainfall, wind, flood, drought, frost, pest, crop production, livestock production, soil fertility, surface and ground water availability, surface and ground water quality, ice, declining trends of grazing land, biodiversity and forest coverage change. The study result revealed that there are no best practices that can be used to tackle all climate change variables. Using a blend of the indigenous adaption strategies across the appropriate contexts is, therefore, of paramount importance.

The major and most frequently used indigenous adaption strategies to climate change by the smallholder farmers are alteration of planting dates, storage of extra harvest for food supply, crop diversification, intercropping, improved Agronomic practices, preparation and using of organic fertilizer, changing cropping mix. Post-harvest handling

techniques are also important adaptation strategies to climate change at it preserve food when shortage was observed. Choosing crop varieties such as early maturing ones and better adapted to the climate change and Agro-ecology was one of the adaptation strategies to climate change. Besides, alteration of crop planting, reducing number of animal, Agro-forestry, conservation tillage, adjusting timing of farm operation such as sowing date and treatment, adjust livestock management, crop and livestock integration, forage production, collection and reserving and consolidating social interaction are important adaptation strategies to climate change.

Farmers are adapting climate change through different indigenous adaption strategies. However, the severity and magnitude of the climate change is tediously increasing from day to day. Therefore, it is imperative to strengthen their adaptive strategies and incorporating scientific strategies through development and implementation of appropriate policies and strategies. To this end, the following recommendations were drawing to tackle climate change hazards:

- Understand, protect and enhance the application of indigenous adaption strategies, which is appropriate for socioeconomic, political and environmental development of the community.
- The study has revealed that despite the potential of the studied areas for irrigation, the proportion of the farm households using irrigation as adaptation strategy to be harmonized with erratic rainfall is less. Therefore, it highly important that government through public agriculture extension service along with development organizations exert efforts on small, medium and large-scale irrigation schemes.
- Ensure the full and effective participation of farmers in relevant agreements, policy and programs at all level.
- Conducting collaborative research among farmers, research institutions and development organizations is also paramount role.

Conflict of interest

The authors have not declared any conflict of interests.

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